CLAIMS

What is claimed is:

1. A method for navigating a UAV, the method comprising:

receiving in a remote control device a user's selection of a GUI map pixel that represents a waypoint for UAV navigation, the pixel having a location on the GUI;

mapping the pixel's location on the GUI to Earth coordinates of the waypoint;

receiving a starting position from a GPS receiver on the UAV;

calculating a heading in dependence upon the starting position, the coordinates of the waypoint, and a navigation algorithm;

identifying flight control instructions for flying the UAV on the heading; and

transmitting the flight control instructions from the remote control device to the UAV.

2. The method of claim 1 further comprising:

receiving user selections of a multiplicity of GUI map pixels representing waypoints, each pixel having a location on the GUI;

mapping each pixel location to Earth coordinates of a waypoint;

assigning one or more UAV instructions to each waypoint;

storing the coordinates of the waypoints and the UAV instructions in computer memory on the remote control device;

flying the UAV to each waypoint in accordance with one or more navigation algorithms; and

operating the UAV at each waypoint in accordance with the UAV instructions for each waypoint, including:

identifying flight control instructions in dependence upon the UAV instructions for each waypoint; and

transmitting the flight control instructions from the remote control device to the UAV.

3. The method of claim 1wherein mapping the pixel's location on the GUI to Earth coordinates of the waypoint further comprises:

mapping pixel boundaries of the GUI map to Earth coordinates;

identifying a range of latitude and a range of longitude represented by each pixel; and

locating a region on the surface of the Earth in dependence upon the boundaries, the ranges, and the location of the pixel on the GUI map.

4. The method of claim 3 wherein locating a region on the surface of the Earth in dependence upon the boundaries, the ranges, and the location of the pixel on the GUI map further comprises:

multiplying the range of longitude represented by each pixel by a column number of the selected pixel, yielding a first multiplicand;

multiplying the range of longitude represented by each pixel by 0.5, yielding a second multiplicand;

adding the first and second multiplicands to an origin longitude of the GUI map;

multiplying the range of latitude represented by each pixel by a row number of the selected pixel, yielding a third multiplicand;

multiplying the range of latitude represented by each pixel by 0.5, yielding a fourth multiplicand; and

adding the third and fourth multiplicands to an origin latitude of the GUI map.

5. The method of claim 1 further comprising periodically repeating the steps of:

receiving in the remote control device from the GPS receiver a current

position of the UAV;

calculating a new heading from the current position to the waypoint;

identifying flight control instructions for flying the UAV on the new heading; and

transmitting, from the remote control device to the UAV, the flight control instructions for flying the UAV on the new heading.

6. The method of claim 1 further comprising identifying a cross track between the starting point and the waypoint, and periodically repeating the steps of:

receiving in the remote control device from the GPS receiver a current position of the UAV;

calculating a shortest distance between the current position and the cross track; and

if the shortest distance between the current position and the cross track is greater than a threshold distance, transmitting flight control instructions that pilot the UAV toward the cross track; and, when the UAV arrives at the cross track, transmitting flight control instructions that pilot the UAV in a cross track direction toward the waypoint.

7. The method of claim 6 wherein calculating a shortest distance between the current position and the cross track comprises:

calculating the distance from the current position to the waypoint;

calculating the angle between a direction from the current position to the waypoint and a cross track direction;

calculating the tangent of the angle; and

multiplying the tangent of the angle by the distance from the current position to the waypoint.

8. The method of claim 1 further comprising identifying a cross track having a cross track direction between the starting point and the waypoint, and periodically repeating the steps of:

receiving in the remote control device from the GPS receiver a current position and a current heading of the UAV;

calculating an angle between the direction from the current position to the waypoint and a cross track direction; and

if the angle is greater than a threshold angle, transmitting flight control instructions that pilot the UAV toward the cross track, and, upon arriving at the cross track, transmitting flight control instructions that pilot the UAV in the cross track direction toward the waypoint.

9. The method of claim 8 wherein the threshold angle is a variable whose value

varies in dependence upon a distance between the UAV and the waypoint.

10. The method of claim 1 further comprising periodically repeating the steps of:

receiving in the remote control device from the GPS receiver a current position of the UAV;

calculating a direction to the waypoint from the current position;

calculating a heading in dependence upon wind speed, wind direction, air speed, and the direction to the waypoint;

transmitting flight control instructions for turning the UAV to the heading; and

transmitting flight control instructions for flying the UAV on the heading.

11. The method of claim 1 further comprising identifying a cross track; calculating a cross track direction from the starting position to the waypoint; and periodically repeating the steps of:

receiving in the remote control device from the GPS receiver a current position of the UAV;

calculating a shortest distance between the cross track and the current position; and

if the shortest distance between the cross track and the current position is greater than a threshold distance, transmitting flight control instructions for piloting the UAV to the cross track, and, when the UAV arrives at the cross track:

receiving in the remote control device from the GPS receiver a new current position of the UAV;

calculating, in dependence upon wind speed, wind direction, air speed, and the cross track direction, a new heading;

transmitting flight control instructions for turning the UAV to the new heading; and

transmitting flight control instructions for flying the UAV on the new heading.

12. A system for navigating a UAV, the system comprising:

means for receiving in a remote control device a user's selection of a GUI map pixel that represents a waypoint for UAV navigation, the pixel having a location on the GUI;

means for mapping the pixel's location on the GUI to Earth coordinates of the waypoint;

means for receiving a starting position from a GPS receiver on the UAV;

means for calculating a heading in dependence upon the starting position, the coordinates of the waypoint, and a navigation algorithm;

means for identifying flight control instructions for flying the UAV on the heading; and

means for transmitting the flight control instructions from the remote control device to the UAV.

13. The system of claim 12 further comprising:

means for receiving user selections of a multiplicity of GUI map pixels representing waypoints, each pixel having a location on the GUI;

means for mapping each pixel location to Earth coordinates of a waypoint;

means for assigning one or more UAV instructions to each waypoint;

means for storing the coordinates of the waypoints and the UAV instructions in computer memory on the remote control device;

means for flying the UAV to each waypoint in accordance with one or more navigation algorithms; and

means for operating the UAV at each waypoint in accordance with the UAV instructions for each waypoint, including:

means for identifying flight control instructions in dependence upon the UAV instructions for each waypoint; and

means for transmitting the flight control instructions from the remote control device to the UAV.

14. The system of claim 12 wherein means for mapping the pixel's location on the GUI to Earth coordinates of the waypoint further comprises:

means for mapping pixel boundaries of the GUI map to Earth coordinates;

means for identifying a range of latitude and a range of longitude represented by each pixel; and

means for locating a region on the surface of the Earth in dependence upon the boundaries, the ranges, and the location of the pixel on the GUI map.

15. The system of claim 14 wherein means for locating a region on the surface of the Earth in dependence upon the boundaries, the ranges, and the location of the pixel on the GUI map further comprises:

means for multiplying the range of longitude represented by each pixel by a column number of the selected pixel, yielding a first multiplicand;

means for multiplying the range of longitude represented by each pixel by 0.5, yielding a second multiplicand;

means for adding the first and second multiplicands to an origin longitude of the GUI map;

means for multiplying the range of latitude represented by each pixel by a row number of the selected pixel, yielding a third multiplicand;

means for multiplying the range of latitude represented by each pixel by 0.5, yielding a fourth multiplicand; and

means for adding the third and fourth multiplicands to an origin latitude of the GUI map.

16. The system of claim 12 further comprising:

means for receiving in the remote control device from the GPS receiver a current position of the UAV;

means for calculating a new heading from the current position to the waypoint;

means for identifying flight control instructions for flying the UAV on the new heading; and

means for transmitting, from the remote control device to the UAV, the flight control instructions for flying the UAV on the new heading.

17. The system of claim 12 further comprising:

means for identifying a cross track between the starting point and the waypoint;

means for receiving in the remote control device from the GPS receiver a current position of the UAV;

means for calculating a shortest distance between the current position and the cross track;

means for transmitting flight control instructions that pilot the UAV toward the cross track if the shortest distance between the current position and the cross track is greater than a threshold distance; and

means for transmitting flight control instructions that pilot the UAV in a cross track direction toward the waypoint when the UAV arrives at the cross track.

18. The system of claim 17 wherein means for calculating a shortest distance between the current position and the cross track comprises:

means for calculating the distance from the current position to the waypoint;

means for calculating the angle between a direction from the current position to the waypoint and a cross track direction;

means for calculating the tangent of the angle; and

means for multiplying the tangent of the angle by the distance from the current position to the waypoint.

19. The system of claim 12 further comprising:

means for identifying a cross track having a cross track direction between the starting point and the waypoint;

means for receiving in the remote control device from the GPS receiver a current position and a current heading of the UAV;

means for calculating an angle between the direction from the current position to the waypoint and a cross track direction; and

means for transmitting flight control instructions that pilot the UAV toward the cross track if the angle is greater than a threshold angle; and

means for transmitting flight control instructions that pilot the UAV in the cross track direction toward the waypoint when the UAV arrives at the cross track.

20. The system of claim 19 wherein the threshold angle is a variable whose value varies in dependence upon a distance between the UAV and the waypoint.

21. The system of claim 12 further comprising:

means for receiving in the remote control device from the GPS receiver a current position of the UAV;

means for calculating a direction to the waypoint from the current position;

means for calculating a heading in dependence upon wind speed, wind direction, air speed, and the direction to the waypoint;

means for transmitting flight control instructions for turning the UAV to the heading; and

means for transmitting flight control instructions for flying the UAV on the heading.

22. The system of claim 12 further comprising:

means for identifying a cross track;

means for calculating a cross track direction from the starting position to the waypoint;

means for receiving in the remote control device from the GPS receiver a current position of the UAV;

means for calculating a shortest distance between the cross track and the current position;

means for transmitting flight control instructions for piloting the UAV to the cross track if the shortest distance between the cross track and the current position is greater than a threshold distance;

means for receiving in the remote control device from the GPS receiver a new current position of the UAV when the UAV arrives at the cross track;

means for calculating, in dependence upon wind speed, wind direction, air speed, and the cross track direction, a new heading;

means for transmitting flight control instructions for turning the UAV to the new heading; and

means for transmitting flight control instructions for flying the UAV on the new heading.

23. A computer program product for navigating a UAV, the computer program product comprising:

a recording medium;

means, recorded on the recording medium, for receiving in a remote control device a user's selection of a GUI map pixel that represents a waypoint for UAV navigation, the pixel having a location on the GUI;

means, recorded on the recording medium, for mapping the pixel's location on the GUI to Earth coordinates of the waypoint;

means, recorded on the recording medium, for receiving a starting position from a GPS receiver on the UAV;

means, recorded on the recording medium, for calculating a heading in dependence upon the starting position, the coordinates of the waypoint, and a navigation algorithm;

means, recorded on the recording medium, for identifying flight control instructions for flying the UAV on the heading; and

means, recorded on the recording medium, for transmitting the flight control instructions from the remote control device to the UAV.

24. The computer program product of claim 23 further comprising:

means, recorded on the recording medium, for receiving user selections of a multiplicity of GUI map pixels representing waypoints, each pixel having a location on the GUI;

means, recorded on the recording medium, for mapping each pixel location to Earth coordinates of a waypoint;

means, recorded on the recording medium, for assigning one or more UAV instructions to each waypoint;

means, recorded on the recording medium, for storing the coordinates of the waypoints and the UAV instructions in computer memory on the remote control device;

means, recorded on the recording medium, for flying the UAV to each waypoint in accordance with one or more navigation algorithms; and

means, recorded on the recording medium, for operating the UAV at each waypoint in accordance with the UAV instructions for each waypoint, including:

means, recorded on the recording medium, for identifying flight control instructions in dependence upon the UAV instructions for each waypoint; and

means, recorded on the recording medium, for transmitting the flight control instructions from the remote control device to the UAV.

25. The computer program product of claim 23 wherein means for mapping the pixel's location on the GUI to Earth coordinates of the waypoint further comprises:

means, recorded on the recording medium, for mapping pixel boundaries of the GUI map to Earth coordinates;

means, recorded on the recording medium, for identifying a range of latitude and a range of longitude represented by each pixel; and

means, recorded on the recording medium, for locating a region on the surface of the Earth in dependence upon the boundaries, the ranges, and the location of the pixel on the GUI map.

26. The computer program product of claim 25 wherein means for locating a region on the surface of the Earth in dependence upon the boundaries, the ranges, and the location of the pixel on the GUI map further comprises:

means, recorded on the recording medium, for multiplying the range of longitude represented by each pixel by a column number of the selected pixel, yielding a first multiplicand;

means, recorded on the recording medium, for multiplying the range of longitude represented by each pixel by 0.5, yielding a second multiplicand;

means, recorded on the recording medium, for adding the first and second multiplicands to an origin longitude of the GUI map;

means, recorded on the recording medium, for multiplying the range of latitude represented by each pixel by a row number of the selected pixel, yielding a third multiplicand;

means, recorded on the recording medium, for multiplying the range of latitude represented by each pixel by 0.5, yielding a fourth multiplicand; and

means, recorded on the recording medium, for adding the third and fourth multiplicands to an origin latitude of the GUI map.

27. The computer program product of claim 23 further comprising:

means, recorded on the recording medium, for receiving in the remote control device from the GPS receiver a current position of the UAV;

means, recorded on the recording medium, for calculating a new heading from the current position to the waypoint;

means, recorded on the recording medium, for identifying flight control instructions for flying the UAV on the new heading; and

means, recorded on the recording medium, for transmitting, from the remote control device to the UAV, the flight control instructions for flying the UAV on the new heading.

28. The computer program product of claim 23 further comprising:

means, recorded on the recording medium, for identifying a cross track between the starting point and the waypoint;

means, recorded on the recording medium, for receiving in the remote control device from the GPS receiver a current position of the UAV;

means, recorded on the recording medium, for calculating a shortest distance between the current position and the cross track;

means, recorded on the recording medium, for transmitting flight control instructions that pilot the UAV toward the cross track if the shortest distance between the current position and the cross track is greater than a threshold distance; and

means, recorded on the recording medium, for transmitting flight control instructions that pilot the UAV in a cross track direction toward the waypoint when the UAV arrives at the cross track.

29. The computer program product of claim 28 wherein means for calculating a shortest distance between the current position and the cross track comprises:

means, recorded on the recording medium, for calculating the distance from the current position to the waypoint;

means, recorded on the recording medium, for calculating the angle between a direction from the current position to the waypoint and a cross track direction;

means, recorded on the recording medium, for calculating the tangent of the angle; and

means, recorded on the recording medium, for multiplying the tangent of the angle by the distance from the current position to the waypoint.

30. The computer program product of claim 23 further comprising:

means, recorded on the recording medium, for identifying a cross track having a cross track direction between the starting point and the waypoint;

means, recorded on the recording medium, for receiving in the remote control device from the GPS receiver a current position and a current heading of the UAV;

means, recorded on the recording medium, for calculating an angle between the direction from the current position to the waypoint and a cross track direction; and

means, recorded on the recording medium, for transmitting flight control instructions that pilot the UAV toward the cross track if the angle is greater than a threshold angle; and

means, recorded on the recording medium, for transmitting flight control instructions that pilot the UAV in the cross track direction toward the waypoint when the UAV arrives at the cross track.

31. The computer program product of claim 30 wherein the threshold angle is a variable whose value varies in dependence upon a distance between the UAV and the waypoint.

32. The computer program product of claim 23 further comprising:

means, recorded on the recording medium, for receiving in the remote control device from the GPS receiver a current position of the UAV;

means, recorded on the recording medium, for calculating a direction to the waypoint from the current position;

means, recorded on the recording medium, for calculating a heading in dependence upon wind speed, wind direction, air speed, and the direction to the waypoint;

means, recorded on the recording medium, for transmitting flight control instructions for turning the UAV to the heading; and

means, recorded on the recording medium, for transmitting flight control instructions for flying the UAV on the heading.

33. The computer program product of claim 23 further comprising:

means, recorded on the recording medium, for identifying a cross track;

means, recorded on the recording medium, for calculating a cross track direction from the starting position to the waypoint;

means, recorded on the recording medium, for receiving in the remote control device from the GPS receiver a current position of the UAV;

means, recorded on the recording medium, for calculating a shortest distance between the cross track and the current position;

means, recorded on the recording medium, for transmitting flight control instructions for piloting the UAV to the cross track if the shortest distance between the cross track and the current position is greater than a threshold distance;

means, recorded on the recording medium, for receiving in the remote control device from the GPS receiver a new current position of the UAV when the UAV arrives at the cross track;

means, recorded on the recording medium, for calculating, in dependence upon wind speed, wind direction, air speed, and the cross track direction, a new heading;

means, recorded on the recording medium, for transmitting flight control instructions for turning the UAV to the new heading; and

means, recorded on the recording medium, for transmitting flight control instructions for flying the UAV on the new heading.